METHOD AND APPARATUS FOR PROVIDING SIGNAL SYNCHRONIZATION IN A SPREAD SPECTRUM COMMUNICATION SYSTEM

FIELD OF THE INVENTION

The present invention relates to communication systems which employ spread-spectrum signals and, more particularly, to a method and apparatus for providing signal synchronization between a transmitter and receiver in a spread spectrum communication system.

BACKGROUND OF THE INVENTION

Communication systems take many forms. Reference may be made to a book by Robert C. Dixon entitled *Spread Spectrum Systems*, John Wiley & Sons, New York, 1984, which describes many aspects of communication systems. In general, the purpose of a communication system is to transmit information-bearing signals from a source, located at one point, to a user destination, located at another point some distance away. A communication system generally consists of three basic components: transmitter, channel, and receiver. The transmitter has the function of processing the message signal into a form suitable for transmission over the channel. This processing of the message signal is referred to as modulation. The function of the channel is to provide a physical connection between the transmitter output and the receiver input. The function of the receiver is to process the received signal so as to produce an estimate of the original message signal. This processing of the received signal is referred to as demodulation.

Two types of two-way communication channels exist, namely, point-to-point channels and point-to-multipoint channels. Examples of point-to-point channels include wirelines (e.g., local telephone transmission), microwave links, and optical fibers. In contrast, point-to-multipoint channels provide a capability where many receiving stations may be reached simultaneously from a single transmitter (e.g., cellular radio telephone communication systems). These point-to-multipoint systems are also termed Multiple Address Systems (MAS).

Analog and digital transmission methods are used to transmit a message signal over a communication channel. The use of digital methods offers several operational advantages over analog methods, including but not limited to: increased immunity to channel noise and interference, flexible operation of the system, common format for the transmission of different kinds of message signals, improved security of communication through the use of encryption, and increased capacity.

These advantages are attained at the cost of increased system complexity. However, through the use of very large-scale integration (VLSI) technology, a cost-effective way of building the hardware has been developed.

To transmit a message signal (either analog or digital) over a band-pass communication channel, the message signal must be manipulated into a form suitable for efficient transmission over the channel. Modification of the message signal is achieved by means of a process termed modulation. This process involves varying some parameter of a carrier wave in accordance with the message signal in such a way that the spectrum of the modulated wave matches the assigned channel bandwidth. Correspondingly, the receiver is required to recreate the original message signal from a degraded version of the transmitted signal after propagation through the channel. The re-creation is accomplished by using a process known as demodulation, which is the inverse of the modulation process used in the transmitter.

In addition to providing efficient transmission, there are other reasons for performing modulation. In particular, the use of modulation permits multiplexing, that is, the simultaneous transmission of signals from several message sources over a common channel. Also, modulation may be used to convert the message signal into a form less susceptible to noise and interference.

For multiplexed communication systems, the system typically consists of many remote units (i.e., subscriber units) which require active service over a communication channel for short or discrete intervals of time rather than continuous sevice on a communication channel at all times. Therefore, communication systems have been designed to incorporate the characteristic of communicating with many remote units for brief intervals of time on the same communication channel. These systems are termed multiple access communication systems.

One type of multiple access communication system is a frequency division multiple access (FDMA) system. In a FDMA system, the communication channel is divided into several narrow frequency bands. Individual communication channel links are established between two communication units within one of these narrow frequency bands. These communication links are maintained for discrete amounts of time while the two communication units transmit and receive signals. During particular communication links between the two communication units, the communication system does not allow other communication units access to the narrow frequency band within the communication channel which is being utilized by the communication units in the particular communication link.

Another type of multiple access communication system is a time division multiple access (TDMA) system. In a TDMA system, the communication channel is divided into time slices of a time frame to allow communication links between two communication units to exist in the same communication channel simultaneously, but at different time slices. This is accomplished by assigning particular time slices of a time frame to a particular communication link and other time slices to other communication links. During these particular communication links between the two communication units, the communication system does not allow other communication units access to the time slice of the time frame within the communication channel which is being utilized by the communication units in the particular communication link.

Further, another type of multiple access communication system is a spread spectrum system. In a spread spectrum system, a modulation technique is utilized in which a transmitted signal is spread over a wide frequency band within the communication channel. The frequency band is much wider than the minimum bandwidth required to transmit the information being sent. A voice signal, for example, can be sent with amplitude modulation (AM) in a bandwidth only twice that of the information itself. Other forms of modulation, such as low deviation frequency modulation (FM) or single sideband AM, also permit information to be transmitted in a bandwidth comparable to the bandwidth of the information itself. However, in a spread spectrum system, the modulation of a signal to be transmitted often